UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
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Decision Rationale
for
the Roanoke River, Wilson Creek and Ore Branch Bacteriological TMDLs

Signed

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Decision Rationale

Total Maximum Daily Loads for
The Primary Contact Use Impairments on
Wilson Creek, Ore Branch and the Roanoke River

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint and natural background sources, including a margin of safety (MOS) that may be discharged to a water-quality limited waterbody.

This document will set forth the U.S. Environmental Protection Agency's (EPA) rationale for approving the TMDLs for the primary contact (bacteriological) use impairments on Wilson Creek, Ore Branch and the Roanoke River. EPA's rationale is based on the determination that the TMDLs meet the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDLs are designed to implement applicable water quality standards.
2) The TMDLs include a total allowable load as well as individual waste load allocations (WLAs) and load allocations (LAs).
3) The TMDLs consider the impacts of background pollutant contributions.
4) The TMDLs consider critical environmental conditions.
5) The TMDLs consider seasonal environmental variations.
6) The TMDLs include a MOS.
7) There is reasonable assurance that the TMDLs can be met.
8) The TMDLs have been subject to public participation.

II. Background

The Roanoke River Watershed runs through Botetourt, Floyd, Montgomery, Roanoke and Salem Counties, Virginia. The Roanoke River is a large river which discharges directly to Albemarle Sound. The bacteria impairment on the Roanoke River begins approximately 205 miles upstream of its mouth on Albemarle Sound at its confluence with Mason Creek and terminates at the Niagara Dam. Wilson Creek and Ore Branch are two tributaries to the Roanoke River in this area. The 335,000-acre watershed is rural with forested and agricultural lands making up 87 percent of the watershed. Most of the remaining watershed is composed of developed lands.

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In response to Section 303(d) of the CWA, the Virginia Department of Environmental

Quality (VADEQ) listed two segments of the Roanoke River (VAW-L04R-01 and 02), Wilson Creek and an Unnamed Tributary to Wilson Creek (VAW-L02R-02) and Ore Branch (VAW-L04R-04) on Virginia's 1996 Section 303(d) list as being unable to attain the primary contact use due to violations of the bacteriological criteria. The Roanoke River segments were listed for failing to attain the aquatic life use and fish consumption uses as well. At the time of their listing, the state's criteria used fecal coliform as an indicator species and there was an instantaneous standard of 1,000 colony forming units (cfu) per 100 milliliters (ml) and a geometric mean standard of 200 cfu/100 ml. This decision rationale will address the TMDLs for the primary contact use impairments.

Fecal coliform is a bacterium which can be found within the intestinal tract of all warm blooded animals. Fecal coliform indicates the presence of fecal wastes and the potential for the existence of other pathogenic bacteria. The higher concentrations of fecal coliform indicate the elevated likelihood of increased pathogenic organisms.

EPA encouraged the states to use *e.coli* and *enterococci* as the indicator species instead of fecal coliform. A better correlation was drawn between the concentrations of *e.coli* and *enterococci*, and the incidence of gastrointestinal illness. The Commonwealth adopted the *e.coli* and *enterococci* criteria in January 2003. According to the new criteria, streams are evaluated via the *e.coli* and *enterococci* criteria after 12 samples have been collected using these indicator species. Twelve *e.coli* samples have been collected from each of these waters, and they are therefore, assessed according to the new criteria.

As Virginia designates all of its waters for primary contact, all waters are required to meet the bacteriological standard for primary contact. Virginia's standard applies to all streams designated as primary contact for all flows. The *e.coli* criteria requires a geometric mean concentration of 126 cfu/100 ml of water with no sample exceeding 235 cfu/100 ml of water.

Although the TMDL and criteria require the 235 cfu/100 ml of water concentration limit not be exceeded, waters are not placed on the Section 303(d) list if their violation rate does not exceed 10 percent. Therefore, these waters may be deemed as attaining the primary contact use prior to the implementation of all of the TMDL reductions. It is necessary to keep this in mind because the reductions required to attain the instantaneous criteria for *e.coli* in the model are extremely stringent.

The bacteriological TMDLs submitted by Virginia are designed to determine the acceptable load of *e.coli* which can be delivered to the impaired segments, as demonstrated by the Hydrologic Simulation Program Fortran (HSPF), in order to ensure that the water quality standard is attained and maintained. HSPF is a dynamic watershed modeling system that simulates both point and nonpoint sources of pollutants, performs flow routing and simulates water quality. HSPF is considered an appropriate model to analyze the impaired waters because of its dynamic ability to simulate both watershed loading and receiving water quality over a wide range of conditions. The model was run to determine the fecal coliform loading to the listed segments. A translator equation was then used to convert fecal coliform results to *e.coli*.

The bacteriological TMDLs analysis allocates the application/deposition of fecal coliform to land based and instream sources. For land based sources, the model accounts for the buildup and washoff of pollutants from these areas. Buildup (accumulation) refers to the entire complex spectrum of dry-weather processes that deposit or remove (die-off) pollutants between storms.[1] Washoff is the removal of fecal coliform which occurs as a result of runoff associated with storm events. These two processes allow the model to determine the amount of fecal coliform from land based sources which is reaching the stream. Point sources and wastes deposited directly to the stream were treated as direct deposits. Wastes which are deposited directly to the stream do not need a transport mechanism.

Local rainfall and temperature data were needed to develop the model. Weather data provides the rainfall data which drives the TMDL model. Weather data was obtained from the Roanoke Airport and Pulaski weather stations Due to their proximity to the impaired segments, the weather data from these stations was combined.

Continuous stream flow data was available for the Roanoke River from several United States Geological Survey (USGS) gages within the watershed. USGS gage 02056000 was used for the calibration and validation of the hydrologic model. The bacteria loading model was calibrated and validated to VADEQ water quality monitoring stations within the each of the impaired segments.

Table 1 - Summarizes the Specific Elements of the TMDL.

Segment	Parameter	TMDL	WLA	LA	MOS
Wilson Creek	*E.coli* (cfu/yr)	3.70E+11	6.65E+09	3.64E+11	Implicit
Ore Branch	*E.coli* (cfu/yr)	1.03E+11	2.17E+10	8.15E+10	Implicit
Roanoke River	*E.coli* (cfu/yr)	1.40E+14	1.10E+14	3.02E+13	Implicit
Wilson Creek	*E.coli* (cfu/day)	1.01E+09	1.82E+07	9.97E+08	Implicit
Ore Branch	*E.coli* (cfu/day)	2.82E+08	5.94E+07	2.23E+08	Implicit
Roanoke River	*E.coli* (cfu/day)	3.83E+11	3.01E+11	8.27E+10	Implicit

The United States Fish and Wildlife Service has been provided with copies of these TMDLs.

III. Discussion of Regulatory Conditions

[1]CH2MHILL, 2000. Fecal Coliform TMDL Development for Cedar, Hall, Byers, and Hutton Creeks, Virginia.

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing primary contact (bacteriological) use impairment TMDLs for the Roanoke River watershed. EPA is therefore approving these TMDLs. EPA's approval is outlined according to the regulatory requirements listed below.

1) The TMDLs are designed to meet the applicable water quality standards.

Virginia has indicated that excessive levels of fecal coliform due to nonpoint sources (both wet weather and directly deposited nonpoint sources) have caused violations of the water quality criteria and designated uses in the Roanoke River Watershed, including Wilson Creek and Ore Branch. The water quality criterion for fecal coliform was a geometric mean 200 cfu/100 ml or an instantaneous standard of no more than 1,000 cfu/100 ml. Two or more samples over a 30-day period are required for the geometric mean standard. Since the state rarely collects more than one sample over a 30-day period, most of the samples were measured against the instantaneous standard.

The Commonwealth has changed its bacteriological criteria as indicated above. The new *e.coli* criterion requires a geometric mean of 126 cfu/100 ml of water with no sample exceeding 235 cfu/100 ml. The new criterion is more stringent and if the loading remains constant the violation rate should increase.

The HSPF model was used to determine the fecal coliform deposition rates to the land as well as loadings to the stream from direct deposit sources. Once the existing load was determined, allocations were assigned to each source category to develop a loading pattern that would allow the impaired segments to support the *e.coli* water-quality criterion and primary contact use. The following discussion is intended to describe how controls on the loading of *e.coli* to the Roanoke River, Wilson Creek and Ore Branch will ensure that the criterion is attained.

The TMDL modelers determined the fecal coliform production rates within each watershed. Data used in the model was obtained from a wide array of sources, including farm practices in the area, the amount and concentration of farm animals, animal access to the stream, wildlife in the watershed, wildlife fecal production rates, septic systems and their failure rates, sanitary sewer and treatment plant data, land uses, weather, stream geometry, etc.. The model combined all of the data to determine the hydrology and water-quality of the stream. The lands within the watersheds were categorized into specific land uses. The land uses had specific loading rates and characteristics that were defined by the modelers. Therefore, the loading rates are different in lands defined as forested versus pasture. Pasture lands support cattle and are influenced differently by stormwater runoff.

The Roanoke River Watershed bacteria TMDLs model was run using weather data collected from Roanoke Airport and Pulaski weather stations. This data was used to determine the precipitation rates in the watershed which transport land deposited pollutants to the stream

through overland and groundwater flow. Waste that was deposited to the land or stored was subjected to a die-off rate. The longer fecal coliform stayed on the ground the greater the die-off. Materials that were washed off the surface shortly after deposition were subjected to less die-off. The hydrology model of the TMDL was calibrated to a USGS gage in the watershed. The model was calibrated to observed flow data from January 1996 through December 1999. During the calibration process, model parameters are adjusted to create a simulated flow record similar to the observed flow record. The calibrated model is then run against a different set of observed flows while all of the flow parameters are held constant. This process is known as validation and the TMDL model was validated to observed flows from January 2003 through December 2004. If the simulated flows of the model resemble the observed flow data of the validation period, the model is assumed to be accurately representing stream hydrology. The model for the Roanoke River Watershed TMDLs simulated the observed flows in the calibration and validation period well.

The water-quality model for bacteria was calibrated to observed data collected from the Roanoke River Watershed. The model was calibrated to the water-quality monitoring station at river mile 202 of the Roanoke. The simulated results slightly over-predicted the violation rate of both the geometric mean and instantaneous criteria in each watershed. Overall, the water-quality model represented the observed data collected at the water quality monitoring stations very well.

In the next step of the TMDL, the loadings from all sources were manipulated, increased and decreased to determine which sources have the greatest impact on the model. Then the loads were reduced to develop a scenario which will lead to the attainment of criteria. Through the development of this and other similar TMDLs, it was discovered that natural conditions (wildlife contributions to the streams) could cause or contribute to violations of the bacteria criteria. Many of Virginia's TMDLs have called for some reduction in the amount of wildlife contributions.

Bacterial source tracking sampling data collected from the impaired segments demonstrated that bacteria from wildlife represent a significant portion of the total bacterial load. In some instances, the loads from wildlife alone appear to violate the numeric criteria. Many of Virginia's TMDLs, including these TMDLs, have called for some reduction in the amount of wildlife contributions to the impacted streams. EPA believes that a significant reduction in wildlife is not practical and will not be necessary due to the implementation plan discussed below. It should be noted that in order for the impaired waters to be in compliance approximately 90 percent of the time, no reductions are required from wildlife sources. This would be the violation rate necessary for the water to be assessed as attaining criteria for 303(d) listing purposes and corresponds to the Stage 1 implementation goals identified in the TMDLs.

A phased implementation plan will be developed for all streams in which the TMDL calls for reductions in wildlife. In Phase 1 of the implementation, the Commonwealth will begin implementing the reductions (other than wildlife) called for in the TMDL. In Phase 2, which can occur concurrently to Phase 1, the Commonwealth will consider addressing its standards to accommodate this natural loading condition. The Commonwealth has indicated that during

Phase 2, it may develop a Use Attainability Analysis (UAA) for streams with wildlife reductions which are not used for frequent bathing. Depending upon the result of the UAA, it is possible that these streams could be designated for secondary contact.

After the completion of Phase 1 of the implementation plan, the Commonwealth will monitor the stream to determine if the wildlife reductions are actually necessary, as the violation level associated with the wildlife loading may be smaller than the percent error of the model. In Phase 3, the Commonwealth will investigate the sampling data to determine if further load reductions are needed in order for these waters to attain standards. If the load reductions and/or the new application of standards allow the stream to attain standards, then no additional work is warranted. However, if standards are still not being attained after the implementation of Phases 1 and 2, further work and reductions will be warranted.

2) The TMDLs include a total allowable load as well as individual waste load allocations and load allocations.

Total Allowable Loads

Virginia indicates that the total allowable loading is the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest and agricultural land segments) and point sources. Activities that increase the levels of bacteria and sediment to the land surface or their availability to runoff are considered flux sources. The actual value for total loading can be found in Table 1 of this document. The total allowable load is calculated on an annual basis.

Waste Load Allocations

There are several permitted dischargers of bacteria to the Roanoke River. There are 15 small individual dischargers which are permitted under a general permit and are allowed to discharge less than 1,000 gallons of effluent per day with an allowable bacteria concentration at the criterion. There are six individually permitted facilities that are allowed to discharge into the Roanoke River and which are identified on Table 2. These facilities were provided a WLA based on their annual flow and effluent concentration. Permitted facilities which are discharging at the criteria were not required to reduce their loadings. There are 10 permitted dischargers that are permitted under the municipal separate storm sewer system (MS-4) permit. The flow from the MS-4s is based on storm runoff which enters the system and is conveyed to the Roanoke River. Reductions were called for from each of the MS-4s, as these are considered point sources. It is expected that best management practices instituted through the MS-4 permit will reduce land based pollutants in the covered area. Table 2 identifies the required load limits under the three non-general permits.

EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR 122.44(d)(1)(vii)(B), “Effluent limits developed to protect a narrative water-quality criterion, a numeric water-quality criterion, or both, are consistent with

assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR 130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Table #2 – TMDL WLAs for Permitted Dischargers Roanoke River Watershed

Facility Name	Permit Number	Load (cfu/yr)
Roanoke Moose Lodge	VA0077895	8.18E+09
Blacksburg Country Club STP	VA0027481	6.10E+10
Montgomery County PSA	VA0062219	4.34E+11
Shawsville Town - STP	VA0024031	3.48E+11
Western Virginia Water Authority	VA0025020	1.08E+14
Suncrest Heights	VA0028711	3.48E+10
Roanoke County	VAR040022	2.84E+11
City of Roanoke	VAR040004	1.93E+11
Town of Vinton	VAR040026	3.32E+10
City of Salem	VAR040010	2.29E+11
VDOT Roanoke Urban Area	VAR040017	1.07E+10
Virginia Western Community College	VAR040030	1.73E+09
Virginia Medical Center	VAR040050	7.87E+09
Town of Blacksburg	VAR040019	3.15E+09
Town of Christiansburg	VAR040025	2.33E+09
VDOT Montgomery County Urban Area	VAR040016	1.17E+09

Load Allocations

According to Federal regulations at 40 CFR 130.2(g), LAs are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

In order to accurately simulate landscape processes and nonpoint source loadings of bacteria, VADEQ used the HSPF model to represent the impaired watersheds. The HSPF model is a comprehensive modeling system for the simulation of watershed hydrology, point and nonpoint source loadings, and receiving water quality. HSPF uses precipitation data for continuous and storm event simulation to determine total loading to the impaired segments from the various land uses within the watersheds. Tables 3a-c identify the current and TMDL loadings for bacteria to the Roanoke River Watershed.

Table 3a - LA for Bacteria (*E.coli*) for Wilson Creek

Source Category	Existing Load (cfu/yr)	Allocated Load (cfu/yr)	Percent Reduction

Cropland	1.36E+11	6.81E+08	99.5
Developed	1.30E+12	6.50E+09	99.5
Pasture	2.21E+12	1.11E+10	99.5
Forest	8.31E+10	4.15+08	99.5
Livestock - Direct	2.44E+11	0.00	100
Wildlife - Direct	3.45E+12	3.45E+11	90
Failed Septic	9.39E+11	0.00	100

Table 3b – LA for Bacteria (*E.coli*) for Ore Branch

Source Category	Existing Load (cfu/yr)	Allocated Load (cfu/yr)	Percent Reduction
Cropland	0.00	0.00	0.00
Developed	7.74E+08	3.87E+06	99.5
Pasture	1.83E+11	9.17E+08	99.5
Forest	2.44E+10	1.22+08	99.5
Livestock - Direct	9.83E+09	0.00	100
Wildlife - Direct	1.15E+12	8.05E+10	93
Failed Septic	4.33E+11	0.00	100

Table 3c – LA for Bacteria (*E.coli*) for Roanoke River

Source Category	Existing Load (cfu/yr)	Allocated Load (cfu/yr)	Percent Reduction
Cropland	3.21E+12	3.86E+10	98.8
Developed	2.57E+13	3.09E+11	98.8
Pasture	4.03E+13	4.84E+11	98.8
Forest	2.48E+12	2.98E+10	98.8
Livestock - Direct	4.18E+12	0.00	100
Wildlife - Direct	9.18E+13	2.94E+13	68
Failed Septic	4.03E+14	0.00	100

3) The TMDLs consider the impacts of background pollution.

The TMDL considers the impact of background pollutants by considering the bacteria

loadings from background sources like wildlife and forested lands. The TMDL model was also calibrated to observed data which include background pollutant loads.

4) The TMDLs consider critical environmental conditions.

According to EPA's regulation 40 CFR 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading and water-quality parameters. The intent of this requirement is to ensure that the water quality of the North River is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards[2]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum.

The HSPF model was run over a multi-year period to insure that it accounted for a wide range of climatic conditions. The allocations developed in the TMDLs will therefore insure that the criteria are attained over a wide range of environmental conditions including wet and dry weather conditions.

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in stream flow and loadings as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods.

Bacteria loadings also change during the year based on crop cycles, waste application rates, vegetative cover and cattle access patterns. Consistent with the discussion regarding critical conditions, the HSPF model and TMDLs analysis effectively considered seasonal environmental variations through the use of observed weather data over an extended period of time and by modifying waste application rates, crop cycles, and livestock practices.

6) The TMDLs include a margin of safety.

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[2]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL. Virginia included an implicit MOS in the bacteria TMDL through the use of conservative modeling assumptions. For instance, the simulated data had a greater violation rate than the observed data thereby increasing the reductions needed to attain the criteria.

7) There is a reasonable assurance that the TMDLs can be met.

EPA requires that there be a reasonable assurance that the TMDLs can be implemented. WLAs will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program.

8) The TMDL has been subject to public participation.

During the development of the TMDL for the Roanoke River Watershed, public involvement was encouraged through several meetings to discuss and disseminate the Roanoke River Watershed TMDLs. The first public meeting was held on October 7, 2004 at the Department of Environmental Quality Headquarters in Richmond, Virginia with 41 people in attendance. The second public meeting was held on August 4, 2005 at the East Montgomery High School in Shawsville, Virginia with 11 people in attendance. All of the public meetings were noticed in the Virginia Register and open to a 30-day public comment period. Written comments were received after the final public meeting.